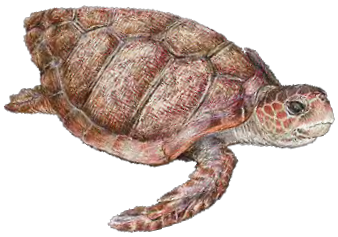
Plastics in the Water Column



Topics
Density, Plastics

Grades
6-8

Site
Indoors

Duration
45 min

Materials
See page 2

Vocabulary
benthic, buoyancy, density, pelagic, plastic, surface

Next Generation Science Standards

Practices

Developing and using models

Core Ideas

ESS3.C Human impacts on Earth systems

Crosscutting Concepts

Cause and effect

Performance Expectations

See page 5

Focus Question

Where can you find plastic in the water column and how might it affect the animals that live there?

Overview

What happens when plastics enter the ocean? Students find out by exploring the densities of different plastics. They then investigate feeding strategies and locations (surface, pelagic and benthic) of various ocean animals and predict how plastics will affect marine food webs. The activity ends with students brainstorming actions to reduce the amount of plastics that end up as waste.

Objectives

Students will be able to:

- Describe how the density of plastic affects its location in the ocean water column.
- Explain how food webs can be disrupted by marine debris.
- Take actions to reduce the amount of single-use plastic used in their households and/or classrooms.

Background

Plastics are materials composed of repeating chainlike-molecules called polymers, and are usually derived from fossil fuels. Many everyday objects are made out of plastic. It is a material that is often strong, lightweight, flexible and durable. Due to plastic's chemical structure and durability, it doesn't biodegrade. It does however photodegrade, which means plastics are broken down into smaller pieces by the absorption of light from the sun's UV rays. Plastics of all shapes and sizes, including the small pieces, end up in the water column as marine debris and can entangle or are consumed by marine animals. It's estimated than 90% of floating marine debris is plastic.

Some plastics float in sea water, others sink and some remain neutrally buoyant. Density is one factor that affects the **buoyancy** and location of the plastic debris in the water column. **Density** is the ratio of a material's mass to its volume. Density is the same value for a certain type of material, regardless of the size of the object. Density can be calculated by dividing an object's mass by its volume

(D=M/V). Density is an important property of all materials, whether solid, liquid, or gas. It measures a material's compactness, or how much mass is squeezed into a given space. If plastic is more dense than sea water, it will sink. If it's less dense, it will float.

Marine animals feed in different oceanic zones. There is the **surface** zone which is where the water meets air and things float where they can be seen. There is the **pelagic** zone which is the open water column where fish swim and plankton drifts. Finally, there is the **benthic** zone which is on or near the ocean floor. Different plastics will impact different animals depending on the buoyancy of the plastic and the zone in which the animal feeds. Some animals may become entangled in it while others may consume it. One study showed that 267 species worldwide, including 86 percent of all sea turtle species, 44 percent of sea bird species and 43 percent of marine mammal species are impacted by marine debris (Laist, 1997). Sea turtles sometimes mistake plastics for jellyfish. Sea birds that dive into the pelagic zone to feed scoop up plastic fragments and may even feed them to their chicks.

According to the Environmental Protection Agency, over 30 million tons of plastics were thrown away in the United States in 2008. Some of this plastic ends up in the watershed and ultimately, the ocean. People can help marine animals by reducing the amount of single-use plastic they use. Taking reusable bags to the grocery store, buying a reusable water bottle and buying products with less packaging all reduce plastics in the waste stream. Supporting legislation that bans plastic bags is another way to reduce marine debris.

VOCABULARY

Benthic: on or near the bottom of an ocean or lake

Density: mass divided by the volume of an object, or the amount of matter in a given volume

Pelagic: the open waters or sea, not the surface or the bottom

Plastic: durable material made of chained molecules, doesn't biodegrade

Surface: on or near the top of the water

Materials

Per student:

- **Ocean Feeder** card
- **Plastics in the Water Column** student sheet (pages 6-7)

Per student group:

- **Density Table** (page 8)
- Tall bucket or other container (transparent is best) filled with water
- Various plastic objects with differing densities and buoyancies (plastic fork, plastic bag, DVD case, plastic bottle and so on)
- Hand lenses
- Towels (for clean up)
- **Water Column Cross Section** (page 12)

Teacher Preparation

1. Gather the materials. Ensure you have internet access on which to view the video "Synthetic Sea" (http://www.algalita.org/movs/pelagic_plastic_mov.html). Each student group should get a 1.5- to 2-foot tall transparent container filled with fresh water. (It needs to be tall enough for a plastic object to be completely submerged.) Bring in various rinsed-out plastic containers from a recycling bin. You may want to experiment with submerging items in water to ensure there are a variety that will sink and float.

2. Make copies of the **Density Table** (one for each group), **Ocean Feeder Cards** (enough for each student to have one cut-out card) and **Plastics in the Water Column** (copy for each student). Either make one copy of the **Water Column Cross Section** for each group or a transparency to project for the class.

3. Give students homework the day before the activity. In a science notebook or on a piece of paper have them look around their home and make a list of 10 plastic items or products and the resin identification codes (if the items have one).

Procedure

1. **Introduce the focus question.**
Share the question: *Where can you find plastic in the water column and how might it affect the animals that live there?* You may write it up on the whiteboard or have students add it to their science notebook. Give students time to write their initial thoughts down or discuss with a partner.

Part One: Density and Buoyancy

2. **Students explore the buoyancy of a variety of plastic objects.**
Pass out the **Plastics in the Water Column** student sheets, the plastic objects and a large container of water to each student group. Have them look for the resin identification code (number in the recycling symbol) on the various objects (look on the bottom of the object, some may not have one) and predict whether each plastic object sinks or floats. Have them record their predictions in a science notebook or on the student sheet. Then have them submerge each object underwater and record their findings. (If an object is not completely submerged, it will appear to float due to surface tension.) *Which floated? Which sank? Why?*

The mission of the Monterey Bay Aquarium is to inspire conservation of the oceans.

3. **Students examine the density of the plastic objects.**
Challenge students to figure out why the buoyancy of each object varied. *(certain plastics are more dense than water so they sink, others are less dense and float)* Pass out the **Density Table** of plastic densities. You may need to provide more information on density depending on students' prior knowledge. *Density (D) is the mass (M) of an object divided by its volume (V).* Have students complete the **Plastics in the Water Column** student sheet.

Part Two: Impacts on Marine Food Webs

4. **Introduce the idea of plastics in the watershed and ocean.**
Ask students how plastic may reach the ocean. Then show them "Synthetic Sea" (at www.algalita.org/video/synthetic-sea-plastic-in-the-open-ocean-by-bill-macdonald/) and share statistics from Algalita Marine Foundation about plastics found in the watershed. How do they think plastics impact marine animals? *(consumption, entanglement)*

5. **Students each get an Ocean Feeder card.**
Ask students where they think animals feed in the ocean. Introduce the concept of feeding zones (benthic=sea floor, pelagic=open water, surface=top of the water column). Pass out an **Ocean Feeder** card to each student or student group. Have them read about their animal and complete the rest of the **Plastics in the Water Column** student sheet.

6. **Students share which plastics may impact their animal with the class.**
Project the **Water Column Cross Section** of the ocean. Have students share information about their animal, plastics that could impact it and why those plastics could impact the animal. You may have them label the plastic code and name on the cross section. See the **Density Table Key** for which plastics float and sink.

WE OURSELVES FEEL THAT WHAT WE ARE DOING IS JUST A DROP IN THE OCEAN. BUT THE OCEAN WOULD BE LESS BECAUSE OF THAT MISSING DROP.

MOTHER THERESA

7. **AS A CLASS, DISCUSS IMPACTS OF PLASTICS ON MARINE ANIMALS.**
   If marine animals consume plastic, what might that do to the food web? *(predators of marine animals that consume plastic indirectly consume plastic, individuals may die, populations may be impacted)* How could plastic on the surface impact a benthic or pelagic animal? *(toxins leach off of plastic into the water, an animal may feed in the surface zone and consume plastic but travel in other zones and be consumed by animals who feed there)*

8. **AS A CLASS, BRAINSTORM WAYS TO REDUCE THE AMOUNT OF PLASTIC CONSUMED.**
   Discuss the alternative material students came up with on their student sheet. Then lead a discussion about pros and cons of plastic. How is it beneficial? *(e.g., contact lenses, medical tubing, lightweight packaging and so on)* What are the cons of plastic? *(doesn't break down, uses fossil fuels, used in disposable products, becomes marine debris, etc.)* Use student's list of plastic items in their homes to make a class chart. Identify items intended for single use versus items intended to be durable. Challenge students to think of ways they can individually use plastic more wisely. *(reusable water bottles, reusable bags at the store, keeping a cell phone until it wears out instead of upgrading every year)* Challenge them to think of ways society can use less. *(not buying as much, buying in bulk so less packaging and so on)*

9. **RETURN TO THE FOCUS QUESTION.**
   Now that students have investigated density and impacts on animals, have students revisit the focus question: *Where can you find plastic in the water column and how might it affect the animals that live there?* Students may think on their own or discuss with a partner. Then in their science notebook, you may have them draw a line of learning and under it add to their original thoughts about the question.

Extensions

Challenge students to create a public service announcement (PSA) or develop some other outreach tool to educate other classes about plastic pollution.

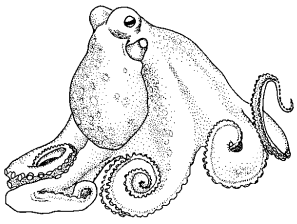
Resources

Websites

Algalita Marine Research Foundation www.algalita.org
Learn more about debris found in the Pacific Gyre as well as research reports and educational resources.

Center for Microbial Oceanography (C-MORE)
http://cmore.soest.hawaii.edu/education/teachers/science_kits/marine_debris_kit.htm
Find several free activities exploring the cause, distribution and biological impacts of marine debris.

Monterey Bay Aquarium www.montereybayaquarium.org
Find information on many marine consumers as well as other classroom activities.



The Story of Stuff Project www.storyofstuff.com
Watch the story of bottled water and access free curriculum resources.

References

Laist, D. W. (1997). Impacts of marine debris: entanglement of marine life in marine debris including a comprehensive list of species with entanglement and ingestion records. In: Coe, J. M. and D. B. Rogers (Eds.), *Marine Debris -- Sources, Impacts and Solutions* (pp. 99-139). New York: Springer-Verlag

Standards

Next Generation Science Standards www.nextgenscience.org

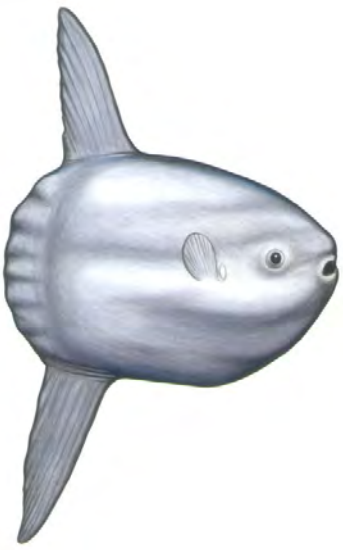
Performance Expectation
Relates to MS-ESS3-3: Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment

Common Core State Standards www.corestandards.org

Science and Technical Subjects , SL.8.1
Reading Science and Technical Subjects: Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table)

Acknowledgements

Adapted from the activity, "You Are What You Eat" pp. 110-116 in *Waves, Wetlands, and Watersheds*, 2003 California Coastal Commission Science Activity Guide.



Name:

Plastics in the Water Column

1. Experiment with a variety of plastic objects.
   a. Record the name of the item and the RIC code (number on object) in the chart below.
   b. Predict whether it will sink or float and record your prediction in the chart below.
   c. Now submerge the items in the water and record your results below.

	Plastic Item	RIC code (number on object)	Prediction: Do you think this plastic sinks or floats?	Results: Did it sink or float?
1.				
2.				
3.				
4.				
5.				

2. Look at the **Density Table** to answer the following questions.

   - Compare the densities of fresh and salt water. Which is more dense? Which is less dense? Why do you think salt water is more dense than fresh water?

   - Which plastics will float in fresh water? Sea water? How do you know?

   - Does that match your findings? Explain. (Think about why you may have gotten different results.)

   - Bonus: Explain how you could make any floating object sink. (Remember that density equals mass divided by volume.)

Plastics in the Water Column

3. Use your Ocean Feeder card to fill in the chart below.

Name of Animal	Location of Feeding (surface, pelagic, benthic)	Diet	Feeding Strategy

4. Refer back to the results of your plastic investigation and the Density Table to answer the following questions.

- Which plastics could affect your animal? Why? (Remember to take into account where your animal feeds and which plastics sink or float in sea water.)

- Would any of the plastic objects you experimented with affect your animal? Explain.

- How might the shape and size of a plastic object determine how your animal is affected? (Think of your animal's feeding strategy and size of its mouth.)

5. Choose one single-use plastic object from your experiment. Answer the following questions:

- What kind of plastic is it?

- What is it used for?

- Are there alternative materials from which this object could be made? If it's plastic packaging, are there ways you could obtain the product without plastic? Explain.

6. Are there ways to reduce our plastic consumption? Explain.

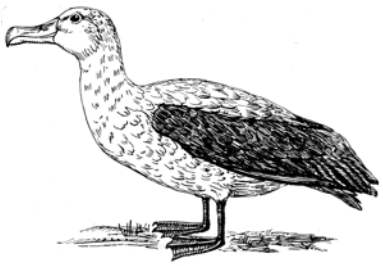
Density Table

Resin ID Code	Name	Density (g/mL)	Uses
	Plastics		
1	**PETE** Polyethylene terephthalate	1.38-1.39	Soft drink and water bottles, peanut butter containers, salad dressing and vegetable oil containers
2	**HDPE** High-density polyethylene	0.95-0.96	Milk jugs, detergents, household cleaners, motor oil containers, some garbage bags, butter and yogurt tubs
3	**PVC** Polyvinyl chloride	1.16-1.45	Clear food packaging, medical equipment, siding, piping, windows, shampoo bottles
4	**LDPE** Low-density polyethylene	0.92-0.94	Squeezable bottles, various bags (for bread, frozen food, shopping and dry cleaning), clothing, furniture
5	**PP** Polypropylene	0.90-0.91	Syrup bottles, ketchup bottles, caps, straws, medicine bottles
6	**PS** Polystyrene (two kinds)	0.020-1.07	CD cases, meat trays, egg cartons, disposable plates and cups
7	**Other** Many kinds	Varies	DVD cases, iPod packaging, signs and displays, nylons
	Other Substances		
	Fresh Water	1.00	
	Sea Water	1.03	

Density Table Key

Resin ID Code	Name	Density (g/mL)	Uses	Where in the Water Column
	Plastics			
1	**PETE** Polyethylene terephthalate	1.38-1.39	Soft drink and water bottles, peanut butter containers, salad dressing and vegetable oil containers	Sinks: benthic feeders (octopus, otter, bass)
2	**HDPE** High-density polyethylene	0.95-0.96	Milk jugs, detergents, household cleaners, motor oil containers, some garbage bags, butter and yogurt tubs	Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)
3	**PVC** Polyvinyl chloride	1.16-1.45	Clear food packaging, medical equipment, siding, piping, windows, shampoo bottles	Sinks: benthic feeders (octopus, otter, bass)
4	**LDPE** Low-density polyethylene	0.92-0.94	Squeezable bottles, various bags (for bread, frozen food, shopping and dry cleaning), clothing, furniture	Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)
5	**PP** Polypropylene	0.90-0.91	Syrup bottles, ketchup bottles, caps, straws, medicine bottles	Floats: surface and pelagic feeders (gull, turtle, albatross, sunfish)
6	**PS** Polystyrene (two kinds)	0.020-1.07	CD cases, meat trays, egg cartons, disposable plates and cups	Sinks or Floats: surface (gull, albatross) or benthic feeders (octopus, otter, bass)
7	**Other** Many kinds	Varies	DVD cases, iPod packaging, signs and displays, nylons	Varies: potentially all feeders
	Other Substances			
	Fresh Water	1.00		
	Sea Water	1.03		

Ocean Feeder Cards



Black-footed Albatross

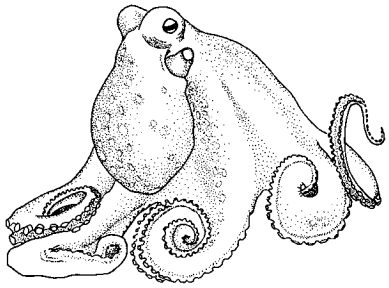
Black-footed albatross — **Surface and Pelagic Feeder**
Phoebastria nigripes size: wingspan up to 7 ft. (215 cm) and 7.7 lbs. (3.5 kg)

This seabird spends three years at sea when it first leaves the nest. It lands on the water to sleep and eat. It locates prey with a keen sense of smell. Parents regurgitate their prey to feed their chicks.
Diet: squid, fish, fish eggs, crustaceans
Feeding Strategy: forages on the surface while swimming or dives underwater to catch food with beak
Habitat: open ocean (sandy shore during breeding)

Giant Sea Bass

Giant sea bass — **Pelagic and Benthic Feeder**
Stereolepus gigas size: to 8.2 ft. (2.5 m), 562 lbs. (255 kg)

These fish are able to quickly and dramatically change colors. Often known as black sea bass, these large fish aren't known for speed. Thus they often feed on the ocean floor.
Diet: sting rays, skates, lobster, crabs, flatfish
Feeding Strategy: catch prey by rapidly opening large mouth; hide in shadows of kelp to ambush some prey
Habitat: open water

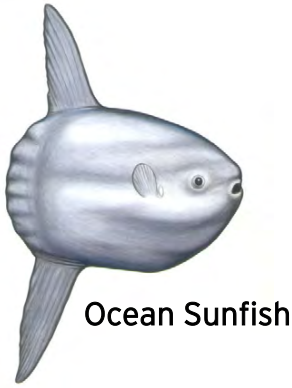


Giant Pacific Octopus

Giant Pacific octopus — **Benthic Feeder**
Enteroctopus dofleini size: to 50 lbs. (23 kg) and 15-ft. (4.5 m) wide

This octopus has over 2,000 suckers through which it grips, smells and tastes. It is able to change its color to camouflage into its surroundings.

Diet: clams, abalone, rockfish, crabs, other octopuses
Feeding Strategy: catches food with suckers and crushes with beak
Habitat: reefs and pilings

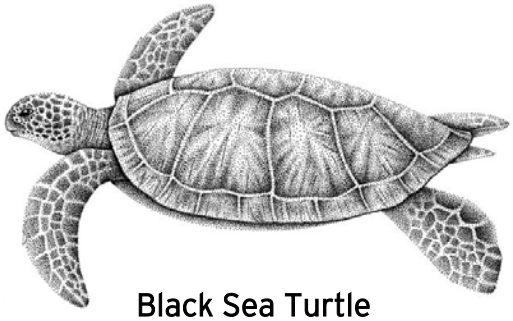


Ocean Sunfish

Ocean sunfish — **Pelagic Feeder**
Mola mola size: to 14 ft. (4.3 m), 5,000 lbs.(2,268 kg) (up to 1,000 lbs. in Monterey Bay)

This fish hatches from a tiny egg and grows up to be the size of a small pickup truck. Ocean sunfish live in almost all of the world's oceans and often swim at the surface sometimes appearing to sunbathe!
Diet: jellies, plankton, small fishes like anchovies
Feeding Strategy: slurps food through fused teeth, shredding prey until its small enough to swallow
Habitat: open water

Ocean Feeder Cards

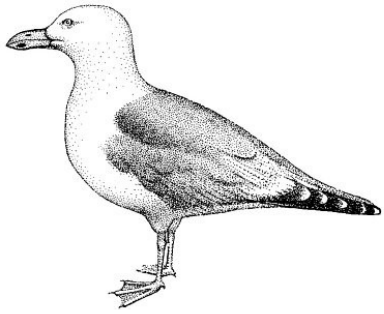


Black Sea Turtle

Black sea turtle **Pelagic Feeder**
Chelonia agassizii size: to 4 ft. (1.2 m)

This sea turtle is actually a type of green sea turtle. As a juvenile, it feeds in the open ocean on invertebrates, algae and jellies. As an adult, it becomes primarily an herbivore and moves closer to shore, eating sea plants.

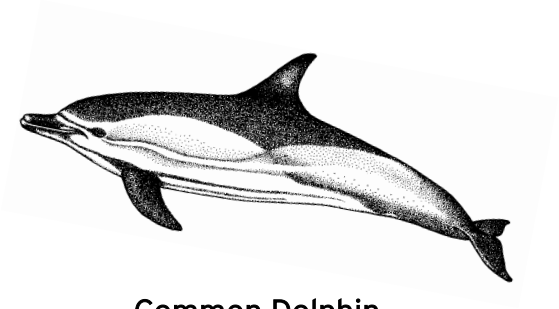
Diet: jellies, invertebrates, sea plants, algae
Feeding Strategy: uses sharp beak to cut and tear its food.
Habitat: open water



Western Gull

Western gull **Surface Feeder**
Larus occidentalis size: 24-27 inches (61-70 cm)

To break open prey like clams and sea urchin, this seabird drops its food from high in the air to hard surfaces below. Often fed by humans, contaminants in people food can harm its health.
Diet: fishes, carrion (dead animals), marine invertebrates, birds, birds' eggs, garbage
Feeding Strategy: uses beak to catch small fish at the surface
Habitat: coastal water



Common Dolphin

Common dolphin **Pelagic Feeder**
Delphinus delphus size: to 8 feet (2.5 m), 250 pounds (113 kg)

These dolphins travel in pods of up to 2,000 animals. They are extremely active and ride the waves of large ships and whales. They work together to herd schools of fish into a tight ball and then eat them.

Diet: fishes and squid
Feeding Strategy: catches prey with beaklike mouth
Habitat: open water

Southern Sea Otter

Southern sea otter **Benthic Feeder**
Enhydra lutris size: to 5.5 ft. (1.7 m)

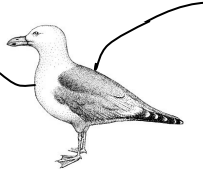
An otter hunts on the seafloor but returns to the surface to eat. It uses its chest as a table. An otter has pockets of skin under each forearm where it can keep prey or tools to crack open its food.

Diet: crabs, snails, urchins, clams and other benthic invertebrates
Feeding Strategy: uses paws to catch and open food
Habitat: kelp forest

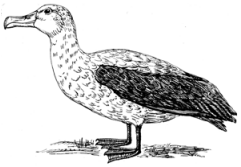
Water Column Cross Section

Some plastics float, some sink. However, all plastics may have an impact on marine animals if they make it into the ocean. Which kinds of plastics may impact which animals? (Hint: use the number on object that indicates the resin identification code.)

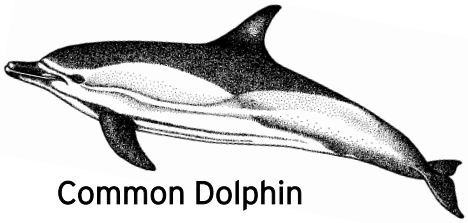
Surface Feeders



Western Gull

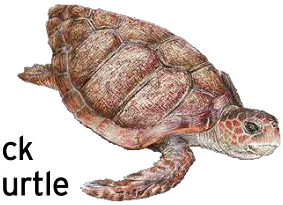


Black-footed Albatross

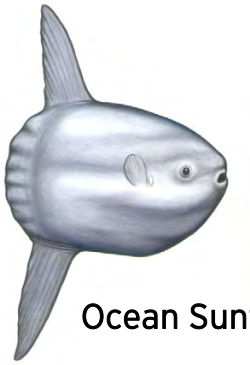


Common Dolphin

Pelagic Feeders



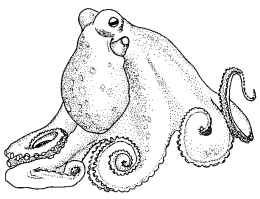
Black Sea Turtle



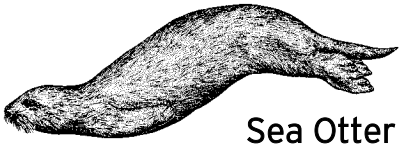
Ocean Sunfish

Giant Sea Bass

Benthic Feeders

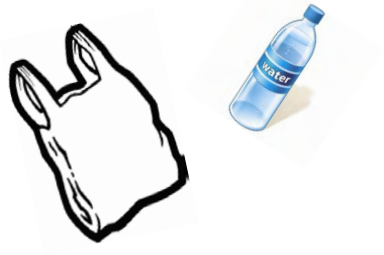


Giant Pacific Octopus



Sea Otter

Does it Sink or Float?



1. Examine the plastic objects.

2. Choose one object and find the resin identification code (number on the bottom of the object).
    - Predict: do you think this item will sink or float? Why?

3. Place the object in the tank of water.
    - What happened?
    - Were you surprised? Why or why not?
    - Do you think the type of plastic relates to whether it sinks or floats? How?

4. Look at the cross section of the ocean.
    - Which animals feed at the surface?
    - Which are pelagic feeders?
    - Which are benthic feeders?

5. Discuss:
    - What would happen if the plastics you tested made it into the ocean? Would any of those animals be affected?
    - Which animals would be affected by which plastics? Why do you think that?